# Chapter 10 Fiber Outside Plant Design and Modeling

New projects are required to build trunkline fiber-optic OSP infrastructure. The central core fiber-optic cable network has already been constructed to the TOC. Additional TOC facilities, such as the Interim TOC (ITOC) in Tucson and Alternate TOC (ATOC) in Peoria, may require additional connectivity to the fiber-optic OSP infrastructure. These TOC facilities inevitably rely on connectivity to the fiber-optic OSP network. New FMS devices coming online will require connectivity to the TOC facilities via new and existing fiber-optic cable and node buildings. This situation creates many challenges for the designer and contractor. Among them are the following:

- Where future trunkline fiber is to be spliced to existing trunkline fiber, each existing spare dark fiber strand proposed for use needs to have its source and destination verified, beginning at the TOC facilities, through every intermediate node building, and ending at the new trunkline connection. End-to-end attenuation of each fiber should be measured unidirectionally (at a minimum) using a laser light source and power meter. The FMS designer needs to account for additional dB loss when splicing to dissimilar fibers. These requirements need to be added to the project Special Provisions once analyzed.
- Completion of new FMS projects will require a rigorous as-built documentation process, where Contractors must document all splice and path loss data. OTDR/power meter testing of all fiber strands in new cables is required to determine the path loss and proper installation of the fiber-optic OSP infrastructure. Construction managers are responsible for certifying that the data supplied by the Contractor is accurate prior to payment.
- Existing fiber-optic OSP facilities within the project limits need to be documented on the project plans. The design will also require documenting how fiber-optic OSP facilities within the project limits are extended beyond the project limits (with existing fiber-optic OSP infrastructure) to achieve connectivity to existing node buildings and/or TOC facilities.

## 10.1 OSP Model

Ideally, a model of the fiber-optic OSP infrastructure (i.e., origination points, cables, splice closures, hubs, nodes, and devices) would accurately depict the following:

- Geographic Information System (GIS) based model of the OSP;
- Splice data at every splice point; and
- Capability to trace a fiber path from the origination point to every FMS device.

This OSP model involves two types of data: GIS and tabular:

- GIS data is needed to track the physical location of the OSP. GIS data provides for quickly locating OSP facilities quickly when there is a failure on the network. Tabular data tracks the lengths of fiber runs to ensure that fiber losses are accounted for in the design.

- Tabular data describes every fiber strand splice or termination at each node point, i.e., termination point (TOC, node building, or FMS device) or splice closure (No. 9 pull box), including cable foot markings etc.

### 10.1.1 Fiber Splice Tables

Table 10.1 and Figure 10.1 through 10.5 depict five levels of detail used to describe the OSP model.

***Note:*** *These figures are used as examples only.*

**Table 10.1 OSP Model Description**

| LEVEL | MACRO TO MICRO | DESCRIPTION OF COVERAGE | EXAMPLE – SEE FIGURE: |
|---|---|---|---|
| **1** | Macro | Overall FMS Communications Diagram | Fig. 10.1 |
| **2** | | Access Point-to-Access Point | Fig. 10.2 |
| **3** | | Splice Point-to-Splice Point | Fig. 10.3 |
| **4** | | Splice Detail | Fig. 10.4 |
| **5** | Micro | Individual Splice Table | Fig. 10.5 |

Fiber-optic splice information is the foundation of the OSP database. This information is useful in different forms to different users:

- Designers and system managers typically need network information, a macro level view. They concentrate on connecting individual devices to the TOC via the overall network. Details from the macro to the micro level are necessary to design and manage the system. Figure 10.1 through Figure 10.4 illustrate the typical design progression from system, nodes, freeway segments, down to cable segments.
- Contractors and maintenance staff typically need information focused on one specific problem area, usually a splice closure or termination point, hence a micro level view. Finding a specific problem area typically involves a search of documents starting at the macro level and moving to the micro level to “zero in” on the problem.
- Ultimately, the smallest level of interest would be a single splice closure point. An example of a single splice detail, showing the splices before and after construction, is shown in Figure 10.5.
- Designers may be required to generate this type of document in their calculation book as a submittal with other design plans. Contractors may be required to track any as-built changes to these splice details as part of their project System Acceptance Test process.

There are instances where a project will not have communication ring architecture, as illustrated in Figure 10.2.

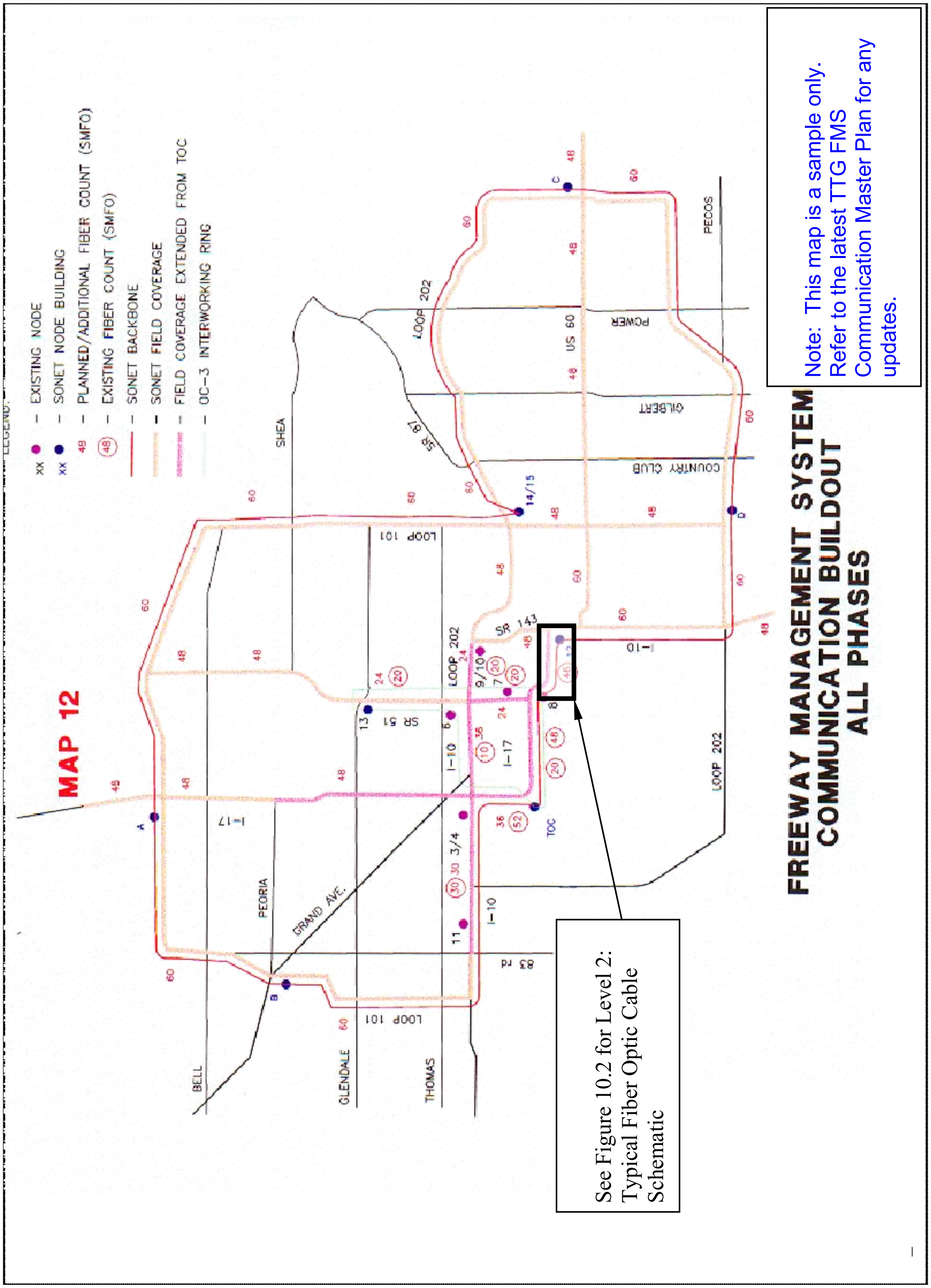


**Figure 10.1 Level 1 Typical Fiber Optic System-wide Schematic**

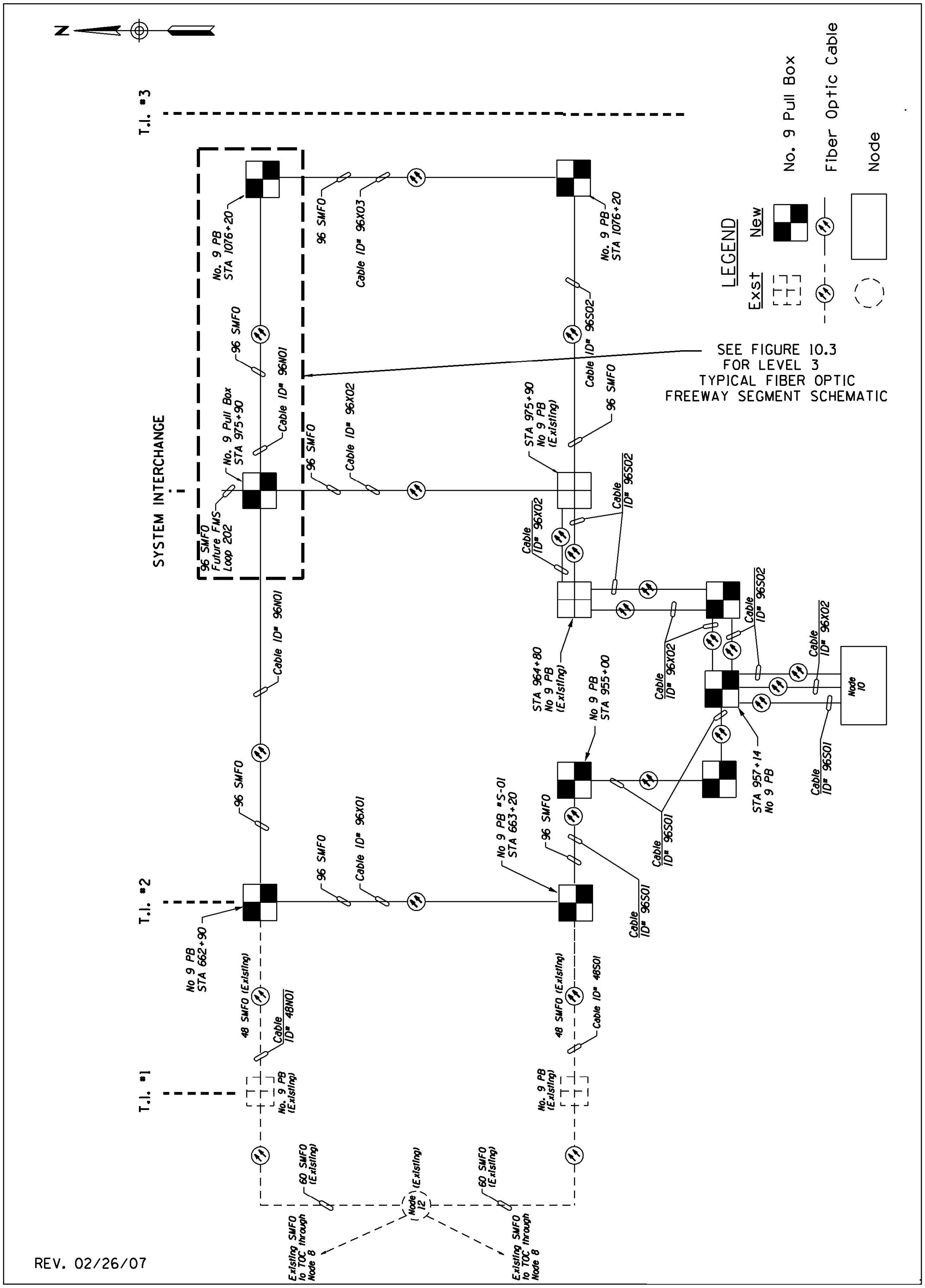


Figure 10.2 Level 2 Typical Fiber Optic Cable Schematic

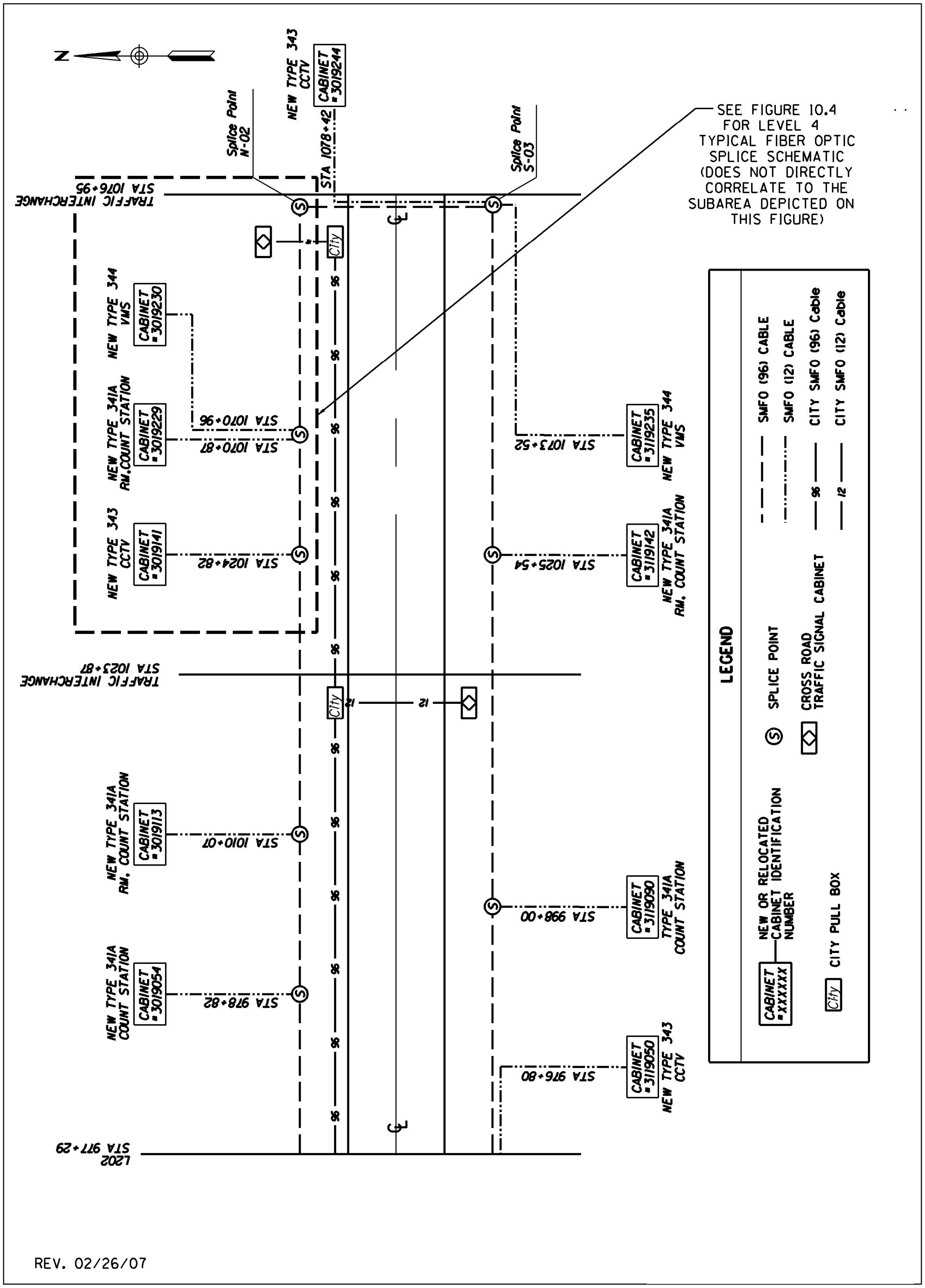


Figure 10.3 Level 3 Typical Fiber Optic Freeway Segment Schematic

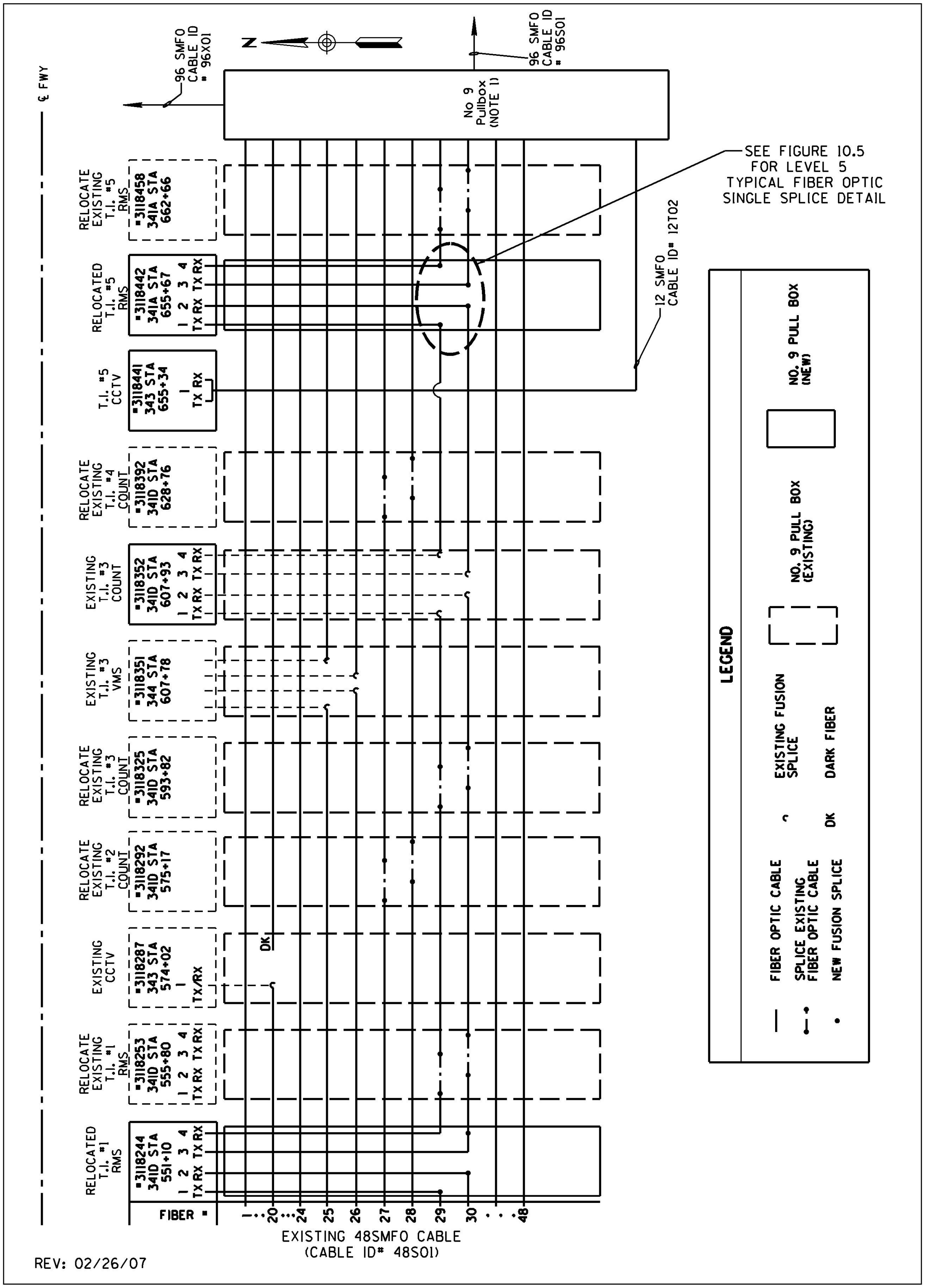


**Figure 10.4 Level 4 Typical Fiber Optic Splice Schematic**

**Figure 10.5 Level 5 Typical Fiber Optic Single Splice Detail**

# 10.2 OSP Software

Designers should be familiar with the current Computer Aided Design (CAD) software used by ADOT. Design of fiber OSP for ADOT will utilize the same CAD software as FMS design, traffic design, roadway design, etc.

ADOT has also initiated the use of OSP software specifically for tracking OSP infrastructure. The designer should coordinate with the ADOT TTG PM on the requirements of the current version of the OSP Software.

The designers should provide a CAD design that facilitates translation of the as-built version of the design into the OSP software database.

**Table 10.2 Translating Data**

<table>
<tr><th colspan="4">♦ TRANSLATING DATA FROM CAD SOFTWARE TO OSP SOFTWARE</th></tr>
<tr><td colspan="2">Fiber Infrastructure ⇨</td><td>Location of cables, splice closures, and termination points</td><td>Fiber-optic splice table</td></tr>
<tr><td rowspan="2">DESIGNER</td><td>Type of data ⇨</td><td><u>Geographic</u></td><td><u>Tabular</u></td></tr>
<tr><td>CAD Software Environment</td><td>CAD Software</td><td>CAD elements connected to relational database with “tags”.</td></tr>
<tr><td></td><td></td><td>↓</td><td>↓</td></tr>
<tr><td rowspan="2">ADOT</td><td>OSP Software Environment</td><td>Shape file (4 or 5 file extensions)</td><td>Access (.mdb)/Oracle relational database file</td></tr>
<tr><td>Translation method from CAD Software to OSP Software</td><td>CAD Software add on modules for full interoperability for translating CAD elements (lines, arcs, cells, etc.,) to shape files with level, color, and weight control.</td><td>Tag values attached to fiber infrastructure CAD elements, such as fiber splice, GPS, identification, and other tabular data reside in the relational database accessible also by OSP Software</td></tr>
</table>

Recommendations for designers:

- CAD design files of fiber-optic cable infrastructure should be connected to the same relational database that is connected to the OSP Software. The infrastructure elements tracked in the OSP Software should be identified. Typical elements include fiber-optic cables, enclosures, pull boxes, splice closures, and termination points/devices.
- When using the OSP Software database designers must utilize tag sets that agree with the relational database elements. For example, a tag set for a splice closure could include the location description pull box; the number for that location as it is designated in the database, e.g., “614”; the identifier for each cable connecting to the splice closure “SMFO-96”; the destination of the next splice closure on that cable “615”; and status of each fiber in that cable “fiber 1: spliced / not spliced”, “fiber 2: spliced/ not spliced”.

- Defining a tag library from scratch may be avoided by importing tag definitions from the relational database to create the library.
- Designers should be required to attach tags to each element in the CAD file that has a counterpart in the relational database. Designers should fill in all tag values associated with each tagged element.
- Designers will need to specify in the project special provisions the specific nomenclature that will be used for each OSP Software field. It will be the designer's responsibility to coordinate with the ADOT TTG PM on the current version of the OSP Software.

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